MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022/2023 (TERM ID 2210 & TERM ID 2215)

PIP 0255 - INTRODUCTION TO PHYSICS

(Foundation in IT Students only)

13 FEBRUARY 2023
2.30 p.m – 4.30 p.m
(2 hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of **5** pages only (excluding cover page and appendices page) with **5** Questions only.

2. Answer **ALL FIVE** structured questions. All questions carry equal marks and the distribution of the marks for each question/section is given.

3. Please print all your answers in the Answer Booklet provided.

STRUCTURED QUESTIONS [5 questions × 10 MARKS = 50 MARKS in TOTAL]

Instruction: Answer **ALL FIVE** questions. *Provide your calculation steps whenever possible.*

Question 1 (10 marks)

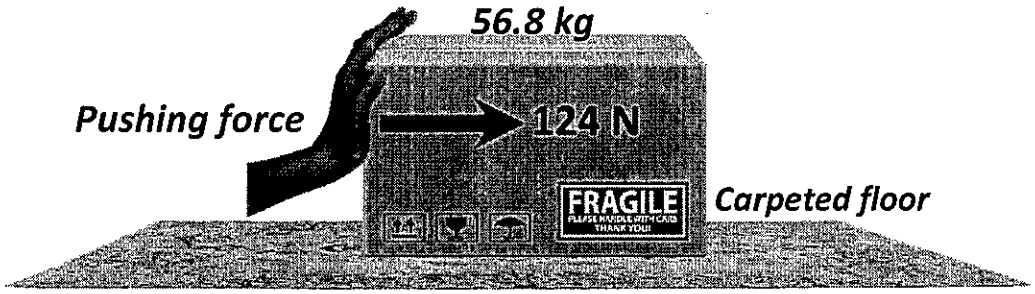

Figure 1.1

(a) Refer to **Figure 1.1**. A box with a mass of **56.8 kg** is pushed along a carpeted floor with a horizontal force of **124 N**. The *coefficient of kinetic friction* (μ_k) between the box and the carpeted floor is **0.120**. If a total (net) work of **74.4 J** is done on the box, how far (distance) along the carpeted floor does the box move? Take $g = 9.8$ m/s^2. **(4 marks)**

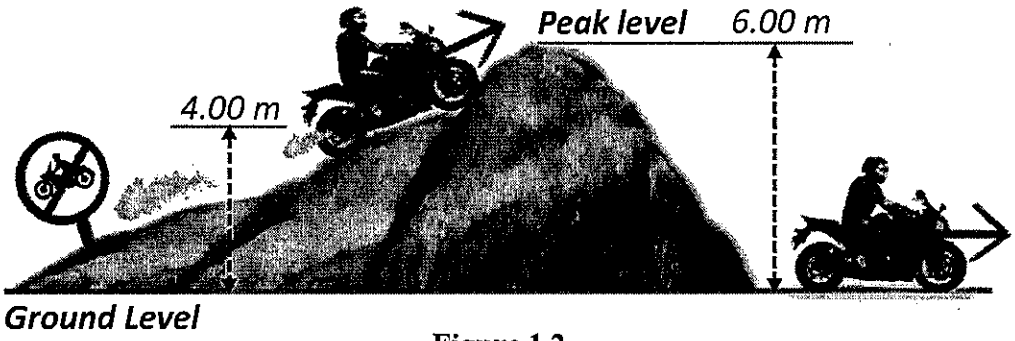

Figure 1.2

(b) Refer to **Figure 1.2**. A motorcyclist rides his motorbike up a small hill during a practice session. At a height of **4.00 meters** (from the gound level), the motorbike's engine dies off and the motorbike then coasts up the hill with a velocity of **6.50 m/s**. The peak of the small hill is **6.00 meters** (from the ground level). Take $g = 9.8$ m/s^2. Ignoring friction and assuming that *mechanical energy* is fully conserved, answer the following:

(i) What is the *velocity* of the motorbike when it reaches the hill's peak? **(3 marks)**

(ii) From the peak of the small hill, the motorbike then rolls down the hill till it reaches the road below (at ground level). What is the expected *velocity* of the motorbike (the engine is still dead at this point) when it reaches the road below? **(3 marks)**

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Question 2 (10 marks)

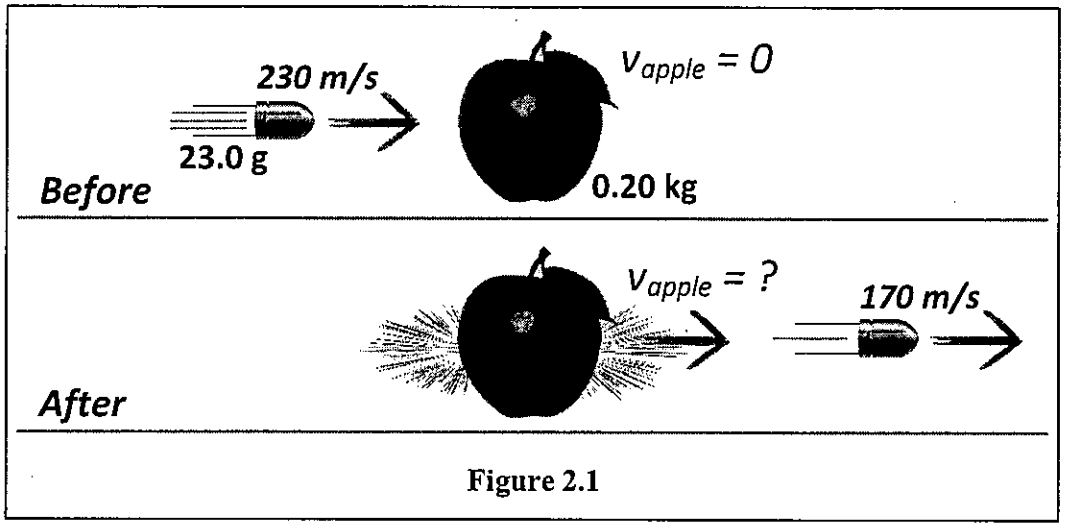

Figure 2.1

(a) Refer to **Figure 2.1**. A **23.0 g** bullet travelling horizontally (in the +ve x direction) at a velocity of **230 m/s** goes through a **0.20 kg** apple and emerges cleanly at a velocity of **170 m/s**. The apple is initially stationary on a frictionless surface when it is penetrated by the bullet. Assuming that the masses of the apple and the bullet both remain the same after the bullet goes through the apple, determine the following:

(i) The apple's *velocity* (+ve x direction) after the bullet goes through it. **(1 mark)**

(ii) The loss in *kinetic energy* for the entire system (both apple and bullet). **(3 marks)**

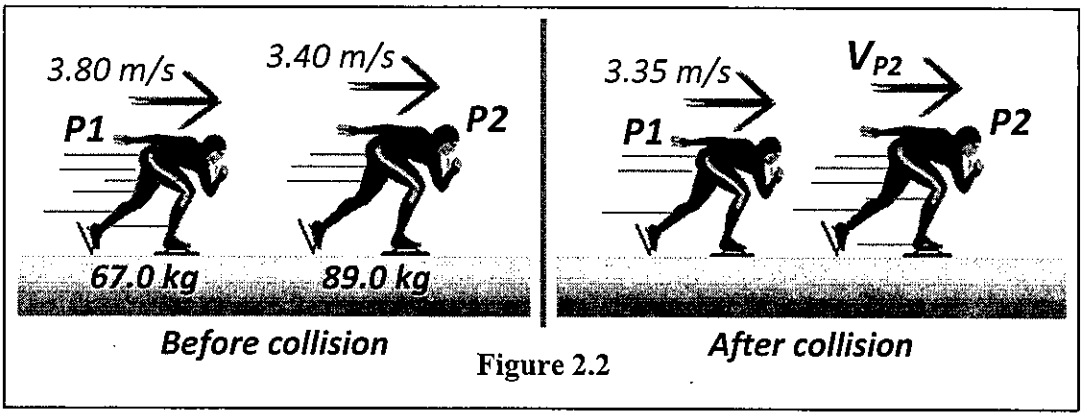

Figure 2.2

(b) Refer to **Figure 2.2**. Two ice-skaters collide as the 1st ice-skater (***P1***) approaches the 2nd ice-skater (***P2***) from behind. The 1st ice-skater has a mass of **67.0 kg** while the 2nd ice-skater has a bigger mass of **89.0 kg**. Before the collision, the 1st ice-skater approaches with a velocity of **3.80 m/s** and the 2nd ice-skater is moving at **3.40 m/s** in the same direction as the 1st ice-skater. After the collision, the 1st ice-skater moves with a velocity of **3.35 m/s** (same direction). Based on this, answer the following:

(i) What is the *velocity*, V_{P2}, of the 2nd ice-skater (***P2***) after the collision? **(2 marks)**

(ii) Is this collision between the two ice-skaters an *elastic* or an *inelastic* collision? Provide the supporting calculation as evidence to support your answer. **(4 marks)**

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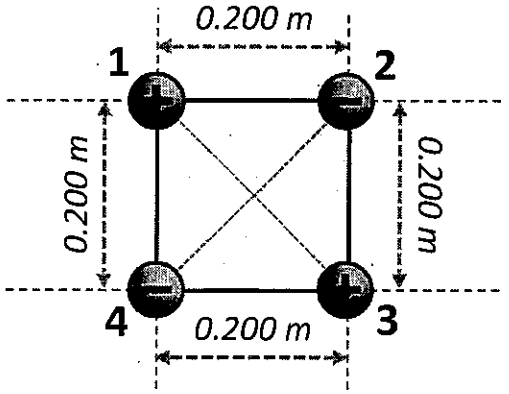
Question 3 (10 marks)



1 = +0.5 μC

2 = −0.5 μC

3 = +0.5 μC

4 = −0.5 μC

Figure 3.1

(a) Refer to **Figure 3.1**. Four point charges are fixed in place at the four corners of a square with sides of the equal lengths of **0.200 m**. These four point charges are labeled as "**1**", "**2**", "**3**" and "**4**" (clockwise order) and their charges are **+0.5 μC**, **−0.5 μC**, **+0.5 μC** and **−0.5 μC** respectively. Take *k*, *Coulomb's constant* as 9.00×10^9 Nm^2/C^2. Based on this information, answer the following:

(i) Sketch all the four point charges (without indicating the length) in **Figure 3.1** and indicate all the forces acting on each of the four point charges. **(2 marks)**

(ii) What is the net *electrostatic force* on charge "**3**" due to the other three charges? **(6 marks)**

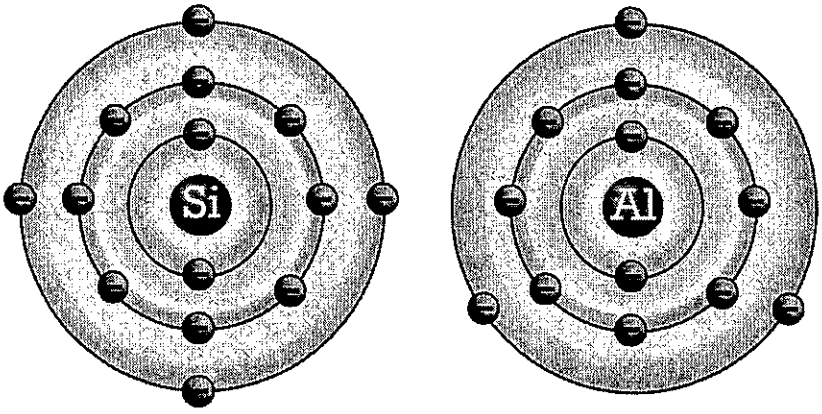


Figure 3.2

(b) The *electron configuration* for silicon (Si) atom and aluminum (Al) atom are depicted in **Figure 3.2**. If impurities like aluminum are added to intrinsic semiconductor material such as silicon, the result will be called *P-type semiconductor* material. What is the molecular structure of *P-type semiconductor* material? Include terms such as *valence electrons* and *covalent bonds* in your description of the molecular structure. **(2 marks)**

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Question 4 (10 marks)

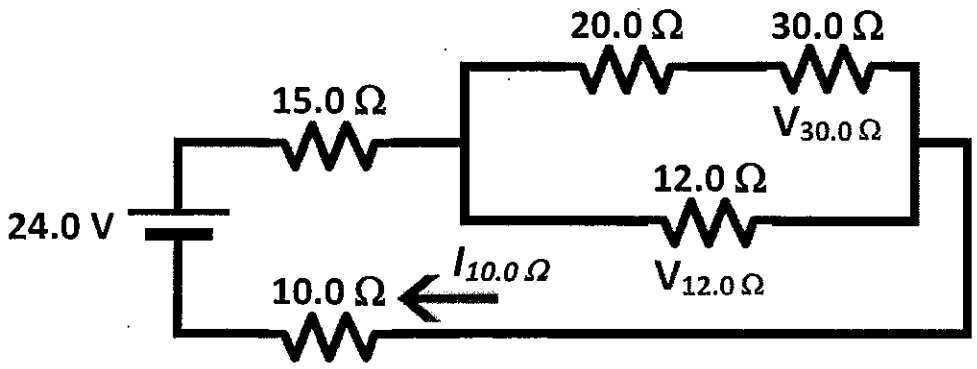

Figure 4.1

(a) Refer to **Figure 4.1**. The circuit above consists of five resistors of different resistance (**10.0 Ω, 12.0 Ω, 15.0 Ω, 20.0 Ω** and **30.0 Ω**) arranged in a *series-parallel* combination with a battery source of **24.0 V**. Based on this circuit, answer the following:

(i) What is the *equivalent resistance* of this circuit? **(2 marks)**

(ii) What is the *current* that flows through the **10.0 Ω** resistor ($I_{10.0\,\Omega}$)? **(1 mark)**

(iii) What is the *voltage drop* across the **12.0 Ω** resistor ($V_{12.0\,\Omega}$)? **(1½ mark)**

(iv) What is the *voltage drop* across the **30.0 Ω** resistor ($V_{30.0\,\Omega}$)? **(1½ mark)**

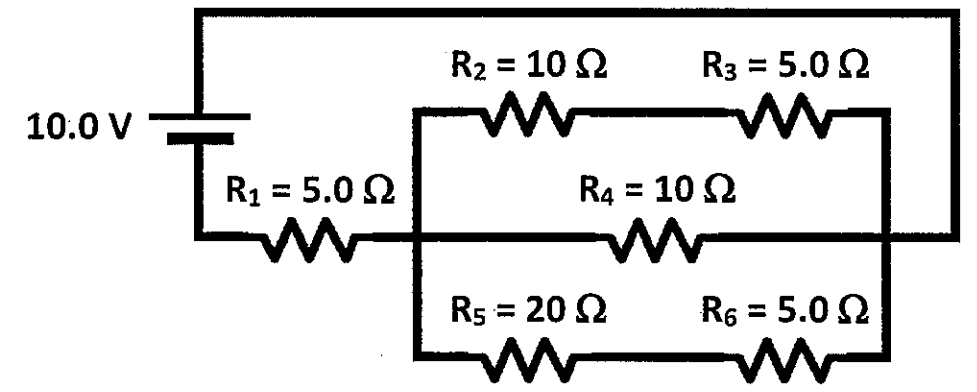

Figure 4.2

(b) Refer to **Figure 4.2**. The circuit above has a *series-parallel* arrangement of six resistors (R_1 = **5.0 Ω**, R_2 = **10 Ω**, R_3 = **5.0 Ω**, R_4 = **10 Ω**, R_5 = **20 Ω** and R_6 = **5.0 Ω**) with a battery source of **10.0 V**. Based on this circuit, answer the following:

(i) What is the *equivalent resistance* of this circuit? **(2 marks)**

(ii) Which of the six resistors in the circuit above has the smallest *voltage* across it? Provide the necessary calculation to support your answer. **(2 marks)**

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Question 5 (10 marks)

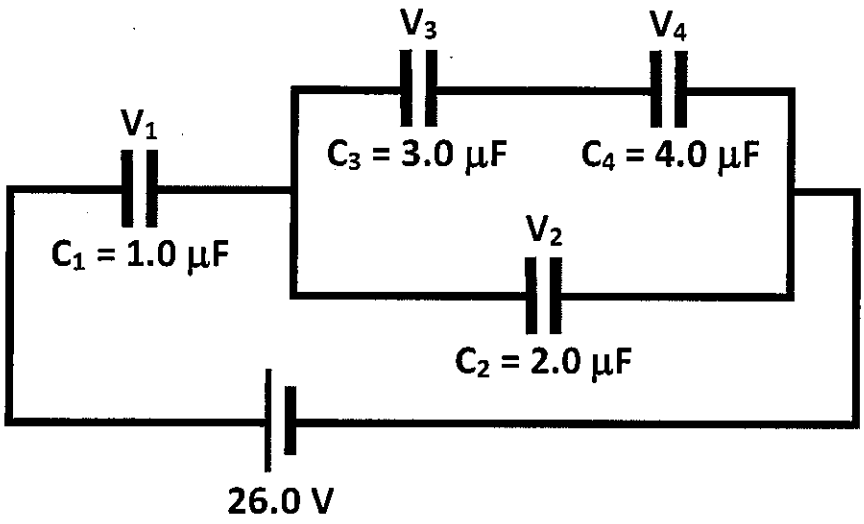

Figure 5.1

(a) Refer to **Figure 5.1**. A **3.0 μF** capacitor (C_3) and a **4.0 μF** capacitor (C_4) are connected in *series*, and this combination is connected in *parallel* with a **2.0 μF** capacitor (C_2). Finally, this combination is further connected (in *series*) with a **1.0 μF** capacitor (C_1). A battery, the voltage of **26.0 V** is applied across this *series-parallel* network of four capacitors. Based on this circuit, answer the following:

(i) What is the *equivalent capacitance* of the circuit in **Figure 5.1**? **(2 marks)**

(ii) What is the *voltage* across the **2.0 μF** capacitor (V_2) & the **4.0 μF** capacitor (V_4)? **(2 marks)**

(iii) What is the *charge* stored in the **2.0 μF** capacitor (Q_2) & the **4.0 μF** capacitor (Q_4)? **(2 marks)**

(iv) Which of the four capacitors can store the <u>least</u> *energy*? Provide the calculation to support your answer. **(2 marks)**

(b) What are **TWO** major <u>differences</u> between *N-type semiconductor* material as compared to *P-type semiconductor* material? **(2 marks)**

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APPENDICES

LIST OF PHYSICAL CONSTANTS

Acceleration due to gravity	g	$9.8\ \text{m/s}^2$
Electron mass	m_e	$9.11 \times 10^{-31}\ \text{kg}$
Proton mass	m_p	$1.67 \times 10^{-27}\ \text{kg}$
Elementary charge	e	$1.602 \times 10^{-19}\ \text{C}$
Coulomb constant	k	$9.0 \times 10^{9}\ \text{N m}^2.\ \text{C}^{-2}$
Permittivity of free space	ε_o	$8.85 \times 10^{-12}\ \text{C}^2\ \text{N}^{-1}.\ \text{m}^{-2}$

LIST OF FORMULA

Quadratic Formula $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ For solving $ax^2 + bx + c = 0$

Kinematics

$v = v_o + at$ $\quad s = \dfrac{1}{2}(v_o + v)t$ $\quad s = v_o t + \dfrac{1}{2}at^2$

$v^2 = v_o^2 + 2as$ $\quad s = vt - \dfrac{1}{2}at^2$

Circular Motion Centripetal acceleration, $a_R = \dfrac{v^2}{r}$ $\quad v = \dfrac{2\pi r}{T}$

Work & Energy Work, $W = Fd\cos\theta$ $\quad KE = \dfrac{1}{2}mv^2$ $\quad PE_G = mgy$

Momentum $p = mv$

Electricity $F = k\dfrac{q_1 q_2}{r^2}$ $\quad C = \dfrac{\varepsilon_0 A}{d}$ $\quad \boxed{Q = CV}$ $\quad V = Ed$

$C_{eq} = C_1 + C_2 + C_3 + \ldots$ $\quad \dfrac{1}{C_{eq}} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3} + \ldots$

$U = \dfrac{1}{2}QV$ $\quad U = \dfrac{1}{2}CV^2$ $\quad U = \dfrac{Q^2}{2C}$ $\quad \boxed{V = IR}$

$R_{eq} = R_1 + R_2 + R_3 + \ldots$ $\quad \dfrac{1}{R_{eq}} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} + \ldots$

$P = IV$ $\quad P = I^2R$ $\quad P = \dfrac{V^2}{R}$ $\quad R = \rho\dfrac{L}{A}$